

We claim:

- 1 1. A microfluidic device comprising:  
2 a card shaped substrate having first and second opposing faces;  
3 one or more microvolumes at least partially defined by a first face of the  
4 card shaped substrate; and  
5 one or more grooves at least partially defined by a second face of the card  
6 shaped substrate;  
7 wherein a lateral footprint of at least a portion of the one or more grooves  
8 overlaps with a lateral footprint of at least one of the one or more microvolumes.
- 1 2. A microfluidic device according to claim 1, wherein the one or more  
2 grooves are sufficiently deep relative to the second face of the substrate within the  
3 overlapping lateral footprint that when the portion of the microvolume within the  
4 overlapping lateral footprint comprises a crystallization sample and an x-ray beam  
5 traverses the card shaped substrate at the overlapping lateral footprint, the portion  
6 of the microvolume that the x-ray beam traverses contains at least half as many  
7 electrons as is contained in the substrate where the x-ray beam traverses.
- 1 3. A microfluidic device according to claim 1, wherein the one or more  
2 grooves are sufficiently deep relative to the second face of the substrate within the  
3 overlapping lateral footprint that when the portion of the microvolume within the  
4 overlapping lateral footprint comprises a crystallization sample and an x-ray beam  
5 traverses the card shaped substrate at the overlapping lateral footprint, the portion  
6 of the microvolume that the x-ray beam traverses contains at least as many  
7 electrons as is contained in the substrate where the x-ray beam traverses.
- 1 4. A microfluidic device according to claim 1, wherein the one or more  
2 grooves are sufficiently deep relative to the second face of the substrate within the  
3 overlapping lateral footprint that when the portion of the microvolume within the  
4 overlapping lateral footprint comprises a crystallization sample and an x-ray beam  
5 traverses the card shaped substrate at the overlapping lateral footprint, the portion  
6 of the microvolume that the x-ray beam traverses contains at least three times as  
7 many electrons as is contained in the substrate where the x-ray beam traverses.

1 5. A microfluidic device according to claim 1, wherein the one or more  
2 grooves are sufficiently deep relative to the second face of the substrate within the  
3 overlapping lateral footprint that when the portion of the microvolume within the  
4 overlapping lateral footprint comprises a crystallization sample and an x-ray beam  
5 traverses the card shaped substrate at the overlapping lateral footprint, the portion  
6 of the microvolume that the x-ray beam traverses contains at least five times as  
7 many electrons as is contained in the substrate where the x-ray beam traverses.

1 6. A microfluidic device according to claim 1, wherein the one or more  
2 grooves are sufficiently deep relative to the second face of the substrate within the  
3 overlapping lateral footprint that when the portion of the microvolume within the  
4 overlapping lateral footprint comprises a crystallization sample and an x-ray beam  
5 traverses the card shaped substrate at the overlapping lateral footprint, the portion  
6 of the microvolume that the x-ray beam traverses contains at least ten times as  
7 many electrons as is contained in the substrate where the x-ray beam traverses.

1 7. A microfluidic device according to claim 1, wherein the one or more  
2 microvolumes comprise at least one lumen.

1 8. A microfluidic device according to claim 7, wherein the groove has a  
2 longitudinal axis that is aligned with a longitudinal axis of the lumen adjacent the  
3 overlapping lateral footprint.

1 9. A microfluidic device according to claim 7, wherein the groove has a  
2 longitudinal axis that is perpendicular to a longitudinal axis of the lumen adjacent  
3 the overlapping lateral footprint.

1 10. A microfluidic device according to claim 1, wherein the one or more  
2 microvolumes comprise at least one lumen with a cross sectional diameter of less  
3 than 2.5 mm.

1 11. A microfluidic device according to claim 1, wherein the one or more  
2 microvolumes comprise at least one lumen with a cross sectional diameter of less  
3 than 1 mm.

1 12. A microfluidic device according to claim 1, wherein the one or more  
2 microvolumes comprise at least one lumen with a cross sectional diameter of less  
3 than 500 microns.

1 13. A microfluidic device according to claim 1, wherein the one or more  
2 microvolumes comprise at least one microchamber.

1 14. A microfluidic device according to claim 1, wherein the substrate  
2 comprises a member of the group consisting of polymethylmethacrylate,  
3 polycarbonate, polyethylene terephthalate, polystyrene, styrene copolymers, glass,  
4 and fused silica.

1 15. A microfluidic device according to claim 1, wherein the substrate is  
2 optically transparent.

1 16. A microfluidic device comprising:  
2 a card shaped substrate having first and second opposing faces;  
3 a plurality of microvolumes at least partially defined by a first face of the  
4 card shaped substrate; and  
5 one or more grooves at least partially defined by a second face of the card  
6 shaped substrate;  
7 wherein a lateral footprint of at least a portion of the one or more grooves  
8 overlaps with lateral footprints of plurality of microvolumes.

1 17. A method for use with a microfluidic device, the method comprising:  
2 performing an experiment in a microfluidic device comprising a card  
3 shaped substrate having first and second opposing faces, one or more  
4 microvolumes at least partially defined by a first face of the card shaped substrate;  
5 and one or more grooves at least partially defined by a second face of the card  
6 shaped substrate; wherein a lateral footprint of at least a portion of the one or more  
7 grooves overlaps with a lateral footprint of at least one of the one or more  
8 microvolumes; and  
9 performing a spectroscopic analysis within the overlapping lateral footprint.

- 1 18. A method according to claim 17, wherein the spectroscopic analysis is  
2 selected from the group consisting of Raman, UV/VIS, IR, x-ray spectroscopy,  
3 polarization, and fluorescent.
- 1 19. A method according to claim 17, wherein the spectroscopic analysis is x-  
2 ray spectroscopy.
- 1 20. A method according to claim 19, wherein the x-ray spectroscopy is x-ray  
2 diffraction.
- 1 21. A method according to claim 17, wherein the spectroscopic analysis  
2 involves an x-ray traversing the microfluidic device.
- 1 22. A method according to claim 21, wherein the groove is sufficiently deep  
2 relative to the second face of the substrate within the overlapping lateral footprint  
3 that when the portion of the microvolume within the overlapping lateral footprint  
4 comprises a crystallization sample and an x-ray beam traverses the card shaped  
5 substrate at the overlapping lateral footprint, the portion of the microvolume that  
6 the x-ray beam traverses contains at least half as many electrons as is contained in  
7 the substrate where the x-ray beam traverses.
- 1 23. A method according to claim 21, wherein the groove is sufficiently deep  
2 relative to the second face of the substrate within the overlapping lateral footprint  
3 that when the portion of the microvolume within the overlapping lateral footprint  
4 comprises a crystallization sample and an x-ray beam traverses the card shaped  
5 substrate at the overlapping lateral footprint, the portion of the microvolume that  
6 the x-ray beam traverses contains at least as many electrons as is contained in the  
7 substrate where the x-ray beam traverses.
- 1 24. A method according to claim 21, wherein the groove is sufficiently deep  
2 relative to the second face of the substrate within the overlapping lateral footprint  
3 that when the portion of the microvolume within the overlapping lateral footprint  
4 comprises a crystallization sample and an x-ray beam traverses the card shaped  
5 substrate at the overlapping lateral footprint, the portion of the microvolume that

6 the x-ray beam traverses contains at least three times as many electrons as is  
7 contained in the substrate where the x-ray beam traverses.

1 25. A method according to claim 21, wherein the groove is sufficiently deep  
2 relative to the second face of the substrate within the overlapping lateral footprint  
3 that when the portion of the microvolume within the overlapping lateral footprint  
4 comprises a crystallization sample and an x-ray beam traverses the card shaped  
5 substrate at the overlapping lateral footprint, the portion of the microvolume that  
6 the x-ray beam traverses contains at least five times as many electrons as is  
7 contained in the substrate where the x-ray beam traverses.

1 26. A method according to claim 21, wherein the groove is sufficiently deep  
2 relative to the second face of the substrate within the overlapping lateral footprint  
3 that when the portion of the microvolume within the overlapping lateral footprint  
4 comprises a crystallization sample and an x-ray beam traverses the card shaped  
5 substrate at the overlapping lateral footprint, the portion of the microvolume that  
6 the x-ray beam traverses contains at least ten times as many electrons as is  
7 contained in the substrate where the x-ray beam traverses.

1 27. A method according to claim 17, wherein the experiment is a  
2 crystallization.

1 28. A method according to claim 17, wherein the experiment is a crystallization  
2 of a biomolecule.

1 29. A method according to claim 17, wherein the experiment is a crystallization  
2 of a molecule at least 500MW.

1 30. A method according to claim 17, wherein the experiment is a crystallization  
2 of a protein.

1 31. The method according to claim 17 wherein the material to be crystallized is  
2 selected from the group consisting of viruses, proteins, peptides, nucleosides,  
3 nucleotides, ribonucleic acids, deoxyribonucleic acids.

1 32. The method according to claim 17 wherein the material to be crystallized  
2 contains at least two or more materials selected from the group consisting of

3 viruses, proteins, peptides, nucleosides, nucleotides, ribonucleic acids,  
4 deoxyribonucleic acids, small molecules, drugs, putative drugs, inorganic  
5 compounds, metal salts, organometallic compounds and elements.

1 33. A method according to claim 17, wherein the one or more microvolumes  
2 comprise at least one lumen with a cross sectional diameter of less than 2.5 mm.

1 34. A method according to claim 17, wherein the one or more microvolumes  
2 comprise at least one lumen with a cross sectional diameter of less than 1 mm.

1 35. A method according to claim 17, wherein the one or more microvolumes  
2 comprise at least one lumen with a cross sectional diameter of less than 500  
3 microns.

1 36. A method for use with a microfluidic device, the method comprising:  
2 performing an experiment in a microvolume of a microfluidic device; and  
3 performing a spectroscopic analysis using an x-ray beam that traverses the  
4 microfluidic device such that material within the microfluidic device that the x-ray  
5 beam traverses contains at least as many electrons as is otherwise traversed when  
6 the x-ray beam traverses the microfluidic device.

1 37. A method according to claim 36, wherein the material within the  
2 microfluidic device that the x-ray beam traverses contains at least three times as  
3 many electrons as is otherwise traversed when the x-ray beam traverses the  
4 microfluidic device.

1 38. A method according to claim 36, wherein the material within the  
2 microfluidic device that the x-ray beam traverses contains at least five times as  
3 many electrons as is otherwise traversed when the x-ray beam traverses the  
4 microfluidic device.

1 39. A method according to claim 36, wherein the material within the  
2 microfluidic device that the x-ray beam traverses contains at least ten times as  
3 many electrons as is otherwise traversed when the x-ray beam traverses the  
4 microfluidic device.

- 1 40. A method according to claim 36, wherein the experiment is a  
2 crystallization.
- 1 41. A method according to claim 36, wherein the experiment is a crystallization  
2 of a biomolecule.
- 1 42. A method according to claim 36, wherein the experiment is a crystallization  
2 of a protein.
- 1 43. A method according to claim 36, wherein the material to be crystallized is  
2 selected from the group consisting of viruses, proteins, peptides, nucleosides,  
3 nucleotides, ribonucleic acids, deoxyribonucleic acids.
- 1 44. A method according to claim 36, wherein the material to be crystallized  
2 contains at least two or more materials selected from the group consisting of  
3 viruses, proteins, peptides, nucleosides, nucleotides, ribonucleic acids,  
4 deoxyribonucleic acids, small molecules, drugs, putative drugs, inorganic  
5 compounds, metal salts, organometallic compounds and elements.
- 1 45. A method according to claim 36, wherein the microvolume comprises is a  
2 lumen.
- 1 46. A method according to claim 36, wherein the microvolume comprises is a  
2 lumen with a cross sectional diameter of less than 2.5 mm.
- 1 47. A method according to claim 36, wherein the microvolume comprises is a  
2 lumen with a cross sectional diameter of less than 1 mm.
- 1 48. A method according to claim 36, wherein the microvolume comprises is a  
2 lumen with a cross sectional diameter of less than 500 microns.
- 1 49. A method according to claim 36, wherein the microfluidic device  
2 comprises a card shaped substrate.